Effects of Intrinsic Pleasantness and Goal Conduciveness Appraisals on Somatovisceral Responding: Somewhat Similar, but Not Identical

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Abstract

In the emotion literature, appraisals of an event's pleasantness and goal conduciveness are often considered as interchangeable and subsumed under the term *valence*. Some appraisal theories, however, emphasize that there is a conceptual difference between these two appraisals. With the current study, we investigated whether such a conceptual difference would be reflected in different somatovisceral response profiles for intrinsic pleasantness and goal conduciveness. Participants viewed unpleasant and pleasant pictures (intrinsic pleasantness) and performed either goal conducive (i.e., decreasing the size of unpleasant pictures, increasing the size of pleasant pictures) or goal obstructive (i.e., increasing the size of unpleasant pictures, decreasing the size of pleasant pictures) arm movements. Our data suggest that the two appraisals have somewhat similar, but not identical, response patterns. Thus, our results emphasize the importance of distinguishing between intrinsic pleasantness and goal conduciveness. Moreover, we find evidence that the efferent effects of the two appraisals combine multiplicatively, and that predictability of goal conduciveness may influence the impact of goal conduciveness appraisals on somatovisceral responding.

Keywords: Emotion, Appraisal, Intrinsic pleasantness, Goal conduciveness, EMG, Zygomaticus major, Corrugator supercilii, Extensor digitorum, Heart rate, Skin conductance, Forehead temperature, Finger temperature

Effects of Intrinsic Pleasantness and Goal Conduciveness Appraisals on Somatovisceral Responding: Somewhat Similar, but Not Identical

Within his component process model of emotion, Scherer (1984, 2009; for a related approach, see Smith, 1989) distinguishes between the two valence-related appraisals *intrinsic pleasantness* (genetically based or learned preferences for specific stimuli) and *goal conduciveness* (stimuli or events evaluated on the basis of whether they help or hinder the attainment of desired needs, goals, or values). For instance, a person on a diet may evaluate chocolate cake as intrinsically pleasant, but at the same time obstructive to the goal of losing weight. This example, among many others, illustrates the important conceptual difference between these two appraisals. Surprisingly, in the emotion literature, appraisals of intrinsic pleasantness and goal conduciveness are often considered as interchangeable and subsumed under the general notion of *valence*.

The somatovisceral effects of intrinsic pleasantness appraisal have been investigated in numerous studies (e.g., Cacioppo, Martzke, Petty, & Tassinary, 1988; Lang, Greenwald, Bradley, & Hamm, 1993). Influences of goal conduciveness appraisal on somatovisceral responding, in contrast, have been studied only rarely (e.g., Aue, Flykt, & Scherer, 2007). Furthermore, an even smaller number of studies have examined somatovisceral effects stemming from intrinsic pleasantness *and* goal conduciveness appraisals. For example, Van Reekum et al. (2004) manipulated the two appraisals in a computer game and reported that intrinsic pleasantness had little impact on the investigated somatovisceral responses. Greater skin conductance response amplitudes were found for pleasant than for unpleasant sounds. Goal conduciveness, in contrast, strongly affected somatovisceral responding, suggesting stronger resource mobilization for obstructive than for conducive events. Higher skin conductance amplitudes and higher activity at the M. extensor digitorum site were observed for the loss of a spaceship than for the attainment of the next level. Consistent with this picture, greater heart rate and shorter pulse transit time appeared for the obstructive as compared with the conducive events.

Smith and Pope (Pope & Smith, 1994; Smith, 1989) described a positive relationship between the pleasantness of an imagined scenario and activity measured at the zygomaticus major site. Activity at the corrugator supercilii site, in contrast, was an indicator of goal obstacles (related to Scherer’s, 2009, goal conduciveness appraisal). Finally, heart rate and skin conductance indexed the anticipated effort in a scenario, supporting the idea of these parameters reflecting individual effort and task engagement.

In an earlier study (Aue & Scherer, 2008), using a similar experimental design as in the current study, we experimentally examined the influence of intrinsic pleasantness and goal conduciveness appraisals on somatovisceral responding. This research suggested that both appraisals provoke similar response patterns for three investigated measures. A positive covariation was found for intrinsic pleasantness and goal conduciveness, on the one hand, and activity measured at the zygomaticus major site, on the other hand. Activity at the corrugator supercilii site, in contrast, varied as a negative function of both appraisals. Somewhat unexpectedly (cf. the predictions of Scherer’s, 2009, component process model and results in the Van Reekum et al., 2004, study), greater heart rate was observed for pleasant images as compared with unpleasant images, and conducive events were associated with a higher heart rate than were obstructive events. This result led us to the conclusion that effects of the two appraisals on heart rate may depend on stimulus proximity (as suggested by Bradley & Lang, 2000), with real-life stimuli as used in the Van Reekum et al. (2004) study yielding higher heart rate for appraisals related to negative valence and more distant stimuli such as pictures yielding higher heart rate for appraisals related to positive valence. Related to this idea of context dependency, we hypothesized that varying the predictability of outcomes (e.g., of goal conduciveness) could modify physiological responses as well.

Moreover, our earlier study (Aue & Scherer, 2008) did not yield unambiguous results for the interaction of intrinsic pleasantness and goal conduciveness appraisals. Whereas the two appraisals combined additively for (i.e., had independent influences on) activity at the zygomaticus major site, they combined multiplicatively for activity at the corrugator supercilii site and heart rate. The aforementioned effects of goal conduciveness on corrugator activity were observed for pleasant images only, whereas effects of goal conduciveness on heart rate were apparent for unpleasant images only.

The first aim of the current study was to replicate and extend the results that we had obtained in our earlier study (Aue & Scherer, 2008). Given the conceptual affinity of intrinsic pleasantness and goal conduciveness, we expected somewhat similar response patterns for these appraisals because both project onto the valence dimension. On the other hand, if, on a conceptual level, it makes sense to distinguish between intrinsic pleasantness and goal conduciveness, it seems reasonable to assume that such a distinction will have different somatovisceral effects as well. Because goal conduciveness can be supposed to be more strongly related to actions, one could, for instance, expect stronger effects on cardiovascular and electrodermal activity for the goal conduciveness as compared with the intrinsic pleasantness appraisal.

The second aim of this study, therefore, was to examine the *degree* of similarity of somatovisceral responses for the intrinsic pleasantness and goal conduciveness appraisals. For this reason, we increased the number of evaluable somatovisceral responses. In addition to the already examined variables in our earlier research (Aue & Scherer, 2008) – activity at the zygomaticus major site, activity at the corrugator site, and heart rate – we included another four variables: activity at the extensor digitorum site, skin conductance, forehead temperature, and finger temperature. Activity at the extensor digitorum site and skin conductance have been related to goal conduciveness before (Van Reekum et al., 2004). Forehead and finger temperature have both been associated with valence, in particular with negatively-valenced emotions (fear and anger; Levenson, Ekman, & Friesen, 1990; McIntosh, Zajonc, Vig, & Emerick, 1997; Stemmler, 2004; Zajonc, Murphy, & McIntosh, 1993). Therefore, skin temperature could be of potential interest in the study of intrinsic pleasantness and goal conduciveness as well.

A third aim concerned the study of the potential influence of the degree of *predictability* of goal conduciveness on somatovisceral responding. Does something that can be foreseen provoke bodily changes that are as dramatic as those produced by something that cannot be foreseen? The latter case seems to call for stronger urgency of response preparation and thus should rely on automatic, prototypical response preparation, and it could possibly be associated with stronger cardiovascular responses. Finally, as evident from the results of our earlier study (Aue & Scherer, 2008), further research is needed to clarify the nature of the intrinsic pleasantness–goal conduciveness interaction (additive versus multiplicative effects), and also whether this nature differs for different investigated somatovisceral variables or different degrees of predictability.

Participants in the present study viewed unpleasant and pleasant pictures (intrinsic pleasantness appraisal) and were instructed to perform either an arm flexion or an arm extension. Following these arm movements, the presented stimuli increased or decreased in size. Unpleasant images have been linked to withdrawal tendencies; pleasant images to approach tendencies (e.g., Lang et al., 1993). Therefore, individuals can be expected to have the goal to maximize pleasant stimulation and to minimize unpleasant stimulation. Consequently, the decrease of unpleasant and the increase of pleasant stimuli should be experienced as goal conducive, whereas the increase of unpleasant and the decrease of pleasant stimuli should be experienced as goal obstructive (goal conduciveness appraisal). Verbal reports in our earlier study (Aue & Scherer, 2008) and a pilot study as well as reaction times in the current study confirmed this hypothesis. To examine the effects of different degrees of predictability of goal conduciveness or obstruction on somatovisceral responses, we added an anticipation manipulation. In one condition, participants could easily anticipate the resulting effect of an arm movement on stimulus size (i.e., goal conduciveness), whereas in the other condition, they did not know until after stimulus onset which arm movement they had to perform and therefore could only minimally anticipate the resulting effect on picture size.

Method

Participants

Forty-two female University of Geneva undergraduates, aged between 18 and 29 years (M = 22.3; SD = 3.04), participated in this study. They were recruited in an introductory psychology course and via ads posted in the university. They were either paid 15 CHF (30 participants) for their participation, or they took part in the context of an introductory psychology course (12 participants). Exclusion criteria for participation were (a) medical treatment, (b) pregnancy, (c) drug abuse, and (d) age below 18 or above 35 years. All participants had normal or corrected-to-normal vision.

For the following reason we decided against a mixed-gender study to avoid artifacts and increase statistical power: While there is no evidence that would lead one to expect gender differences for the appraisal mechanisms under study, gender differences have been reported for physiological responding (e.g., Mendelsohn & Karas, 2005, for cardiovascular, and Greenwald, Cook, & Lang, 1989, as well as Lang et al., 1993, for facial electromyographic variables). As in many other Psychology studies, female participants were used as they are more readily available as participants.

Stimuli and Task

For each experimental block, 10 unpleasant and 10 pleasant pictures were chosen from Lang, Bradley, and Cuthbert's (1999) International Affective Picture System (IAPS) and an own picture evaluation study (see Appendix). Ten neutral images served as filler items. Unpleasant and pleasant pictures were matched for extremity (deviation from scale mean [5]), subjective arousal and complexity. Participants had to perform either an arm extension or an arm flexion (i.e., pushing or pulling a joystick). Following these arm movements, the images either increased or decreased in size, thus visually giving the impression of approach or withdrawal. The increase of unpleasant images and the decrease of pleasant images were considered goal obstructive. Conversely, the decrease of unpleasant images and the increase of pleasant images were considered goal conducive (based on reports in a pilot study and an earlier study; Aue & Scherer, 2008; see also manipulation check in the results section).

The experiment consisted of three blocks that were presented in counterbalanced order.

In the low anticipation block, the appearance of two different symbols superimposed on the pictures approximately 500 ms after picture onset indicated whether the participants had to push or to pull the joystick (low anticipation of picture size change [i.e., low anticipation of goal conduciveness]). The push symbol and the pull symbol were projected onto 15 images each. Participants had to push the joystick five times and to pull it another five times within each pleasantness level. There was no fixed combination of picture and push or pull symbol.

In the two remaining blocks, participants pushed (extension) or pulled (flexion) the joystick on mere picture appearance and could anticipate the resulting effect of their arm movements in advance (high anticipation of picture size change [i.e., high anticipation of goal conduciveness]). In one block, participants always performed an arm extension, in another block always an arm flexion. The combination of these two blocks matches the design of the low anticipation block.

Experimental Design

The experimental design was a 2 × 2 × 2 within-subjects design resulting from the manipulation of the factors *Anticipation* (two levels: low, high), *Intrinsic Pleasantness* (two levels: unpleasant, pleasant) and *Goal Conduciveness* (two levels: obstructive, conducive).

Setting and Apparatus

Participants sat comfortably in a reclining position, facing a computer screen (Sony CPD-E400E) at a distance of approximately 1.4 m (picture size: 16 cm × 24 cm) in a sound attenuated room (3.50 m × 4 m). A Logitech Extreme 3D Pro Twist Handle Joystick (Fremont, CA, USA) was placed on the right side of the participant, permitting the execution of arm extension and arm flexion. The maximum displacement in either the extension or the flexion direction implied a movement of the participant’s hand by 10 cm. The participants’ arms were placed on an armrest to prevent fatigue to the largest possible extent. Physiological data were acquired continuously with the Biopac TEL 100 Remote Monitoring System (Santa Barbara, CA, USA). The sampling rate was set to 1,000 Hz. There were different settings for the electrocardiogram, electrodermal, temperature, and electromyogram (EMG) channels (see Dependent Variables for details). Signals were transferred from the experimental room to the MP100 Acquisition Unit (16 bit A/D conversion) in the control room and stored on computer hard disc (HP Compac d530 CMT). Three separate digital channels received inputs from the presentation computer and recorded on- and offset of (a) a picture, (b) the extension/flexion symbol, and (c) the display of the picture in its new size. Experimental control, such as picture presentation, computer synchronization and reaction time registration, was performed by DirectRT v2004 (Empirisoft Corporation, New York, NY, USA), running on the presentation computer (HP Compac d530 CMT). A hidden camera (Sony EVI-D31) permitted the detection of larger body movements impinging on physiological responses.

Procedure

Participants were informed that they were participating in an experiment on sensorimotor coordination involving the registration of bodily reactions. After their arrival in the laboratory, participants signed an informed consent form and electrodes were placed on them. Next, a 5-min relaxation period began, which allowed the participants to become familiar with the experimental setting and to establish and register a physiological baseline. The performance task consisted of looking at pictures presented on a computer screen (picture size: 256 × 192 pixels) and reacting as rapidly as possible (a) to two symbols appearing superimposed on the pictures approximately 500 ms after picture onset (low anticipation of picture size change), or (b) to the mere appearance of a picture (high anticipation of picture size change). Following the participants' arm movements, the image either increased (640 × 480 pixels, covering the whole screen) or decreased (100 × 75 pixels, details no longer identifiable). The picture in its new size was then presented for 4 s and followed by a black screen (on average 2 s).

For half of the participants, the image became smaller when they pushed the joystick and larger when they pulled the joystick; for the other half, it was the reverse. By having these two groups, we prevented the visual effects (increasing versus decreasing picture size, i.e., approach versus withdrawal) from being confounded with a specific arm movement.[1]

Participants were informed that the four best performers would win 50 CHF each. Criteria for good performance were (a) no movement errors (e.g., not pulling the joystick when pushing was requested or vice versa) and (b) short reaction times. Each performance block was preceded by a training period of six trials. Furthermore, an additional neutral picture was shown as the first picture in each performance block to ensure that reactions to the first relevant picture were not simply an effect of surprise.

In a postinterview, participants were asked about their hypotheses concerning the aim of the study, their involvement, and their physical and psychological well-being. None of the participants indicated physical or psychological disturbance or that she had guessed the real aim of the study. Involvement was considered as having been sufficiently high (M = 2.3, SD = 1.08) on a scale ranging from 0 (*not at all*) to 4 (*extremely*). Before leaving the laboratory, participants were debriefed.

Dependent Variables

EMG activity at the muscle sites M. zygomaticus major, M. corrugator supercilii, and M. extensor digitorum. Skin was first cleansed with PDI (Orangeburg, Canada) electrode prep pads consisting of 70% alcohol and pumice to reduce skin impedance below 5 kΩ. Facial muscle activity was recorded according to the guidelines of Fridlund and Cacioppo (1986) with two 4-mm Biopac Ag/AgCl surface electrodes per site, filled with Signa Gel (Parker Laboratories, Fairfield, NJ, USA). The same kind of electrodes served for the EMG obtained from the M. extensor digitorum. Electrodes were fixed on the participant's left body side. A ground electrode was placed at the midline of the forehead. Amplification was set to 5,000 and signals were high-pass filtered (30 Hz). Signals were then rectified and smoothed by a moving average (length: ± 25 ms).

Heart rate. Electrocardiogram was measured by the use of Biopac pre-gelled disposable Ag/AgCl electrodes (10-mm sensor diameter). Electrodes were fixed according to Einthoven II, one below the right clavicle and another below the left lateral margin of the chest. Amplification was 500, and filters were set to 1 and 45 Hz.

Mean skin conductance. Electrodermal activity was measured with a constant voltage of 0.5 V, using the SS 3A Biopac electrodermal response transducer filled with Biopac GEL 101 electrode paste (formulated with 0.5% saline in a neutral base). The transducer was placed at the volar surfaces of the medial phalanges of the index and third fingers of the left hand Amplification was set to 500 (corresponding to a sensitivity of 20 μS/V), and filters were set to DC and 10 Hz. The signal was smoothed by a moving average (length: ± 200 ms).

Forehead and finger temperature. A Biopac temperature probe (SS 7) was fixed on the forehead to measure skin temperature in degrees Fahrenheit. Finger temperature was measured in degrees Fahrenheit with a Biopac fast response temperature probe (SS 6). Amplification was set to 500 (corresponding to a sensitivity of 10°F/V) and filters were set to DC and 10 Hz. The signals were smoothed by a moving average (length: ± 200 ms).

Data Analysis

Preprocessing of the data. Parameterization was performed with the program PPP 7.12 (2005; eXtra Quality Measurement Systems, Frankfurt am Main, Germany). PPP allowed the assessment of heart period (in seconds), which was then transformed into heart rate (in beats per minute). Mean EMG activity, heart rate, skin conductance, and forehead and finger temperature during the 1 s before stimulus onset served as baseline and were subtracted from mean EMG activity, heart rate, skin conductance, and forehead and finger temperature estimated for the 4 s following stimulus size change.

Outliers in physiological responses were identified with JMP statistical software (SAS Institute Inc., 1995) and set to missing data (~ 2% of the data). EMG measures and mean skin conductance were transformed by the natural logarithm because of positive skewness. Physiological responses related to wrong or late reactions in the reaction time task (~1%) were excluded as well. Two participants did not consistently follow the instructions for the low anticipation block and consequently, their data were eliminated. Another participant was barred from all analyses because of equipment failure. Finally, one participant was excluded from heart rate analyses (due to abnormal arrhythmia), two participants were excluded from finger temperature analyses (sensor detachment), and three were excluded from extensor analyses (electrode detachment).

Statistical analyses. Statistical analyses comprised 2 (anticipation) × 2 (intrinsic pleasantness) × 2 (goal conduciveness) ANOVAs. All reported effect sizes are partial η^2 (in the following simply noted as η^2).

Results

Manipulation Check for the Goal Conduciveness Manipulation: Reaction Times

If, as expected, it were goal conducive for our participants to decrease unpleasant and increase pleasant pictures, we would expect shorter reaction times (RTs) for these instances than for the instances in which unpleasant pictures increased and pleasant pictures decreased. In accordance with our expectations, participants performed the presumably goal conducive (decreasing the size of unpleasant and increasing the size of pleasant images) arm movements more rapidly than the presumably goal obstructive (increasing the size of unpleasant and decreasing the size of pleasant images) arm movements, $F(1, 38) = 4.13$, $p < .05$, $\eta^2 = .10$ (*M*s = 469 ms and 474 ms, respectively). From this difference in reaction time and from verbal reports in an earlier study (Aue & Scherer, 2008) and a pilot study, we concluded that our participants indeed appraised the experimental manipulations on picture size as goal conducive and goal obstructive.

The ANOVA conducted on the reaction time data further yielded a significant main effect for intrinsic pleasantness, $F(1, 38) = 16.77$, $p < .0005$, $\eta^2 = .30$ (*M*s = 475 ms and 468 ms, for unpleasant and pleasant, respectively), a significant main effect for anticipation, $F(1, 38) = 120.40$, $p < .000001$, $\eta^2 = .76$ (*M*s = 533 ms and 410 ms, for low and high anticipation, respectively), and a significant interaction anticipation × intrinsic pleasantness, $F(1, 38) = 8.95$, $p < .005$, $\eta^2 = .19$. Tukey tests for this interaction revealed that RTs for pleasant and unpleasant pictures did not differ in the high anticipation condition ($p = 1.00$). All of the remaining pairwise comparisons were significant (*p*s < .005).

For the sake of brevity, in the following, nonsignificant results that are of limited theoretical relevance will not be discussed. For completeness, all effects in the 2 × 2 × 2 ANOVAs are listed in Table 1.

Activity at the Zygomaticus Major Site

Pleasant images were characterized by greater activity at the zygomaticus major site than were unpleasant images, $F(1, 38) = 20.71$, $p < .0001$, $\eta^2 = .35$ (Figure 1). In a similar vein, conducive trials were associated with higher activity at the zygomaticus major site than were obstructive trials, $F(1, 38) = 4.85$, $p < .05$, $\eta^2 = .11$. The interaction term indicated a multiplicative effect of intrinsic pleasantness and goal conduciveness on activity at the zygomaticus major site, $F(1, 38) = 6.96$, $p < .05$, $\eta^2 = .15$. Whereas conduciveness did not matter for unpleasant images, it did matter for pleasant images: Increasing pleasant images were associated with significantly stronger activity than were decreasing pleasant images. Tukey tests revealed that every experimental condition differed from all others (ps $\leq .08$), except unpleasant-obstructive versus unpleasant-conducive ($p = 1.00$). Variations in anticipation did not moderate the reported effects (Table 1).

Insert Figure 1 and Table 1 about here

Activity at the Corrugator Supercilii Site

Unpleasant images provoked stronger corrugator responses than did pleasant images, $F(1, 38) = 27.93$, $p = .000005$ $\eta^2 = .42$. Similarly, obstructive events were associated with higher activity at the corrugator supercilii site than were conducive events, $F(1, 38) = 17.96$, $p < .0005$, $\eta^2 = .32$. These main effects on corrugator responses were qualified by a number of interactions. First, the interaction of anticipation and intrinsic pleasantness was significant, $F(1, 38) = 7.90$, $p < .01$, $\eta^2 = .17$, revealing a stronger effect for unpleasant versus pleasant events in the high as compared with the low anticipation condition (Tukey tests: ps = .09 and < .0005, for low and high, anticipation, respectively). The significant interaction intrinsic pleasantness × goal conduciveness, $F(1, 38) = 8.82$, $p < .01$, $\eta^2 = .19$, demonstrated, as for the zygomaticus data, the effect of goal conduciveness to exist only for pleasant images (Tukey tests: all ps < .05, except unpleasant-obstructive versus unpleasant-conducive, $p = .99$). Finally, the interaction of anticipation, intrinsic pleasantness, and goal conduciveness was marginally significant, $F(1, 38) = 3.51$, $p = .07$, $\eta^2 = .07$. The latter effect resulted from the fact, that the interaction between intrinsic pleasantness and goal conduciveness was existent in the low anticipation but not in the high anticipation trials, Fs(1, 38) = 8.39 and 0.76, $p < .01$ and *ns*, η^2s = .41 and .02 (yielded by ANOVAs performed separately for the low and high anticipation trials, respectively).

Activity at the Extensor Digitorum Site

Activity at the extensor digitorum site did not show a main effect for intrinsic pleasantness, $F(1, 35) = 0.06$, *ns*, $\eta^2 = .00$, or a main effect for goal conduciveness, $F(1, 35) = 0.09$, *ns*, $\eta^2 = .00$. All other effects failed to reach significance as well (Table 1).

Heart Rate

Pleasant images provoked a stronger increase in heart rate than did unpleasant images, $F(1, 37) = 5.96$, $p < .05$, $\eta^2 = .14$. Conducive situations were associated with a higher heart rate than were obstructive situations, $F(1, 37) = 7.37$, $p = .01$, $\eta^2 = .17$. Again, the interaction intrinsic pleasantness × goal conduciveness reached significance, $F(1, 37) = 5.07$, $p < .05$, $\eta^2 = .12$. Tukey tests revealed a lower heart rate for the unpleasant-obstructive events than for all other combinations of intrinsic pleasantness and goal conduciveness (ps $\leq$ .08), with no difference between the latter ones (ps > .95). Anticipation did not modulate the impact of intrinsic pleasantness and goal conduciveness on heart rate (Table 1).

Mean Skin Conductance

Mean skin conductance was not influenced by intrinsic pleasantness in our study, $F(1, 38) = 0.07$, *ns*, $\eta^2 = .00$, but goal conduciveness had an impact, $F(1, 38) = 3.95$, $p = .05$, $\eta^2 = .09$. Obstructive events were characterized by less habituation than were conducive events. Again, anticipation did not moderate the effects of the two appraisals (Table 1).

Forehead Temperature

Intrinsic pleasantness had no impact on forehead temperature, $F(1, 38) = 0.02$, *ns*, $\eta^2 = .00$. However, there was a significant effect for goal conduciveness, $F(1, 38) = 6.14$, $p < .05$, $\eta^2 = .14$, with obstructive events being associated with a higher forehead temperature than conducive events. This effect was qualified by the significant interaction anticipation × goal conduciveness, $F(1, 38) = 5.63$, $p < .05$, $\eta^2 = .13$. Tukey tests revealed significant differences between obstructive and conducive events in the low anticipation trials only (p < .01, all other *p*s > .28).

Finger Temperature

As for forehead temperature, intrinsic pleasantness did not influence finger temperature, $F(1, 36) = 0.00$, *ns*, $\eta^2 = .00$. The main effect for goal conduciveness was not significant, either, $F(1, 36) = 1.04$, *ns*, $\eta^2 = .03$, but the interaction anticipation × goal conduciveness turned out significant, $F(1, 36) = 4.52$, $p < .05$, $\eta^2 = .11$. Again, Tukey tests demonstrated differences between obstructive and conducive events in the low anticipation condition only ($p < .05$, all other *p*s > .11). Obstructive events produced higher finger temperature than did conducive events in the low anticipation trials.

Discussion

Somewhat Similar, but Not Identical, Effects of Intrinsic Pleasantness and Goal Conduciveness Appraisals

Results for facial EMG and heart rate replicated those we obtained with a similar experimental design (Aue & Scherer, 2008). Pleasant images were associated with higher zygomaticus activity, lower corrugator activity, and higher heart rate than were unpleasant images (see also, Bradley, 2000; Hamm, Schupp, & Weike, 2003). Furthermore, activity at the zygomaticus major site was more elevated, activity at the corrugator supercilii site more attenuated, and heart rate more elevated for conducive as compared with obstructive events (see also Pope & Smith, 1994; Smith, 1989; Van Reekum, 2001). Thus, at first glance, intrinsic pleasantness and goal conduciveness were simultaneously reflected in zygomaticus activity, and their effects pointed into the same direction, which would speak against a need to distinguish intrinsic pleasantness from goal conduciveness appraisals.

However, it is important to note that the effect of intrinsic pleasantness was unmistakably present for both levels of goal conduciveness in both zygomaticus and corrugator activity, whereas goal conduciveness effects were restricted to pleasant images only (except in the high anticipation condition for corrugator activity). In consequence, for facial EMG, we have clear evidence for a stronger effect of intrinsic pleasantness as compared to goal conduciveness.

For heart rate, the picture was slightly different, with unpleasant-obstructive trials being characterized by lower heart rate than all other trials – potentially reflecting greater vigilance or reduced engagement in the reaction time task (see also Bradley & Lang, 2000; Fowles, Fisher, & Tranel, 1982; Pecchinenda & Kappas, 1995; Smith, 1989). Overall, therefore, heart rate data did not allow differentiating between the two appraisals. Activity at the extensor digitorum site did not differentiate between intrinsic pleasantness and goal conduciveness either because it was unaffected by our experimental manipulations. That participants in our study performed arm extensions and flexions with their right arm may have produced systematic changes in extensor activity on the left arm and thus obliterated effects of the two appraisals.

The greatest support for our claim for a need to distinguish between intrinsic pleasantness and goal conduciveness becomes evident when looking at the three remaining physiological variables. Whereas facial EMG demonstrated more robust effects of intrinsic pleasantness than goal conduciveness, mean skin conductance, forehead temperature, and finger temperature were influenced by the goal conduciveness manipulation but not by the intrinsic pleasantness manipulation. Obstructive events were characterized by stronger physiological mobilization, more specifically, by less habituation in mean skin conductance over the experiment (cf. Van Reekum et al., 2004, who also reported higher skin conductance for obstructive as compared with conducive events). They were further characterized by higher forehead temperature and higher finger temperature. Effects on skin temperature, however, were restricted to the low anticipation trials.

Heightened forehead temperature has been repeatedly found in anger (e.g., Stemmler, 2004). Anger-provoking situations are usually characterized by appraisals of goal obstruction and other person responsibility, mostly, but not always, combined with a high level of subjective coping potential appraisal. However, past research on anger has not yet allowed identifying what exactly produces the increase in forehead temperature. Our results suggest that it may be the appraisal of (unexpected) goal obstruction. Consistent with this picture, finger temperature data speak for greater vasodilatation in this body region, which has been interpreted as permitting an individual to perform more fine-grained finger movements, those being important for holding weapons or initiating a fight when experiencing negative emotions such as anger (e.g., Levenson et al., 1990).

In line with our expectations, for some measures related to the autonomic nervous system (mean skin conductance, forehead temperature, and finger temperature), the impact of the goal conduciveness appraisal was stronger than the impact of the intrinsic pleasantness appraisal, which is also consistent with Van Reekum et al.’s (2004) observations. This is not surprising, because the simple fact that something unpleasant or pleasant is presented at a certain “psychological distance” does not necessarily demand resource mobilization for adaptive action preparation. Rather, whether concrete approach or withdrawal behavior is prepared and facilitated should depend much more on the goal conduciveness of the situation (and particularly so if it is unexpected). Such a consideration is also in accordance with the common idea that human beings are strongly engaged in goal-directed behavior.

Most importantly, the possibility that our results can be simply explained by differential induction efficiency or differential intensity of the two appraisals can be discarded because (a) we observed stronger effects of intrinsic pleasantness than goal conduciveness on facial EMG, and (b) there was no effect of intrinsic pleasantness but an effect of goal conduciveness on mean skin conductance and two skin temperature measures. Thus, our results suggest somewhat similar (same-direction effects in facial EMG and heart rate), but clearly not identical, response patterns for the two appraisals under investigation.

Influences of Outcome Predictability on the Relationship between Goal Conduciveness and Somatovisceral Responding

Effects of goal conduciveness on zygomaticus activity, heart rate, and skin conductance were not qualified by predictability. As regards corrugator activity, little anticipated conducive events differed from little anticipated obstructive events only when the stimulus material implicated was pleasant, but not when it was unpleasant. Higher predictability, on the contrary, made the effect of goal conduciveness also arise for unpleasant images. Thus, expressive responses to goal obstruction are amplified by predictability. It is possible that communicative signals are intensified when fewer resources are needed to anticipate what is going to happen in the near future.

Forehead and finger temperature, by contrast, showed an effect of goal conduciveness in the low anticipation block only. Contrary to facial expressions, vascular changes are thus more enhanced during unexpected obstruction, which may be due to greater urgency for an immediate bodily adaptation. The fact that, for both forehead and finger temperature, we observed an effect of goal conduciveness in the low anticipation situation only can further be meaningfully linked to research on anger. The realization that there was at least a chance that something could have happened differently seems to be critical. Recall that in the high anticipation trials, our participants performed 30 consecutive arm flexions and 30 consecutive arm extensions (or vice versa) and the resulting picture size changes would not have been expected to be different. In contrast, in the low anticipation block, participants viewed the image for 500 ms before they even knew which arm movement was requested. Thus, the essential feature producing increased forehead and finger temperature in anger (cf., Levenson, Ekman, & Friesen, 1990; Stemmler, 2004) could well be unexpected goal obstruction.

Interactions of Intrinsic Pleasantness and Goal Conduciveness

The bulk of our data suggests that efferent effects of appraisal outcomes on bodily responding may not be additive but multiplicative in nature. More specifically, in all but one case (activity at the corrugator supercilii site, high anticipation), whenever both intrinsic pleasantness and goal conduciveness had an influence on somatovisceral responding, intrinsic pleasantness and goal conduciveness had clearly multiplicative effects.

Contrary to our earlier study (Aue & Scherer, 2008), zygomaticus responses showed a significant effect of goal conduciveness for pleasant images only. Replicating the result of our previous research, corrugator responses in the low anticipation block also revealed an effect of goal conduciveness for pleasant images only. The data for facial EMG may thus reflect typical everyday communicative human behavior. For example, we often see that people, when talking to others after having been saved (i.e., a goal conducive outcome) from intrinsically unpleasant encounters, still display facial expressions of fear, despair, or disgust. This may be part of a communicative strategy that aims at expressing to and sharing with others the experience of danger or upset that they have been facing before.

Heart rate data also showed multiplicative effects with a strong difference between the unpleasant–goal obstructive events (increasing unpleasant images) and all other events, directly replicating the observations in our previous study (Aue & Scherer, 2008). We have argued that this result may reflect greater vigilance to this specific threat-evoking condition. Evidence for multiplicative somatovisceral effects of appraisals such as control and power, has been obtained before (Van Reekum, 2001; Van Reekum, Johnstone, & Scherer, 1997). In contrast to these coping-potential related appraisals, however, the combined effects of intrinsic pleasantness and goal conduciveness do not seem to be characterized by a crossover interaction.

Limitations of the Current Study

Our results have to be interpreted on the basis of the characteristics of the experimental design, which may limit generalizability. First, and as already noted in the introduction, we do not assume that all relations between appraisals and physiological responding we observed in the current study can be readily generalized across contexts. Rather, we think that some of them may be more, others less context-specific. For instance, the comparison of our own results with Van

Reekum et al.’s (2004) results shows divergence with respect to the influence of goal conduciveness appraisals on heart rate responsivity (cf. Bradley & Lang, 2000), whereas there are less differences across studies as regards facial EMG. Therefore, we think that the link between appraisals and autonomic nervous system activity is more context-dependent than the link between appraisals and facial EMG responses. However, we can imagine specific societal demands or pressures modifying the latter link as well, especially as regards the expression of appraisals of goal conduciveness. Yet, the major conclusion of our study results, namely that it is worth distinguishing between intrinsic pleasantness and goal conduciveness, is in no way challenged by the existence of context-dependency.

Second, the actions of increasing the size of pleasant and decreasing the size of unpleasant stimuli are not necessarily equally goal conducive. The degree of conduciveness may depend on an individual’s relative goal preference (maximization of pleasant versus minimization of unpleasant stimulation). For instance, impulsive persons might prefer to maximize pleasant stimulation, whereas anxious persons might prefer to minimize unpleasant stimulation.

Third, in our study, goal conduciveness varied as a function of intrinsic pleasantness and stimulus size change. This manipulation did not assume cases of decreasing unpleasant stimuli or increasing pleasant stimuli to be goal obstructive. Comparably, increasing unpleasant and decreasing pleasant stimuli were never interpreted as goal conducive. However, situational appraisal in our study may again depend on individual differences. In extreme cases, for example, there might even be an effect of sensation seeking (Zuckerman, 1991) with the observer desiring an increase in the size of an unpleasant stimulus for the sake of titilation. Human beings sometimes enjoy confrontation with intrinsically unpleasant stimuli or situations.

A typical example is the popularity of horror films. However, our reaction time data corroborate the conclusion that the majority of our participants indeed interpreted goal conduciveness in accordance with our intentions.

Conclusions

The results reported in this study underscore the theoretical affinity of the intrinsic pleasantness and goal conduciveness appraisals. However, slightly different results for facial EMG (demonstrating a stronger influence of intrinsic pleasantness than goal conduciveness) as well as obvious differences for the temperature measures and skin conductance (demonstrating an effect of goal conduciveness only) suggest that the two appraisals under investigation show indeed different signatures that only partly overlap.

Our data are in line with research demonstrating that intrinsic pleasantness is appraised significantly earlier than goal conduciveness (Grandjean & Scherer, 2008; Lanctôt & Hess, 2007). Consequently, although our results have to be replicated – ideally with the inclusion of still further somatovisceral variables – accumulating evidence now points to the importance of separating the appraisals of intrinsic pleasantness and goal conduciveness rather than indiscriminately subsuming them under a general positive-negative valence dimension.

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Footnotes

[1]In fact, recent research suggests that the relationship between arm movements and action tendencies such as approach and withdrawal is not hard-wired or fix, contrary to common interpretations of earlier research (e.g., Chen & Bargh, 1999) suggesting approach to be closely related to arm flexion and withdrawal to arm extension. Instead, it has been demonstrated that the relationship can easily be reversed by manipulating the experimental setting (e.g., Seibt et al., 2008; Wentura, Rothermund, & Bak, 2000). Linking both approach and withdrawal consequences to either arm movement enabled us to study, in addition, whether arm flexion really can be more easily linked to approach and arm extension to withdrawal. However, we did not find evidence for such a link. Since this question is beyond the scope of this article, data are not discussed here.

Figure Captions

Figure 1. Somatovisceral changes as a function of intrinsic pleasantness and goal conduciveness. Error bars depict standard errors. Electromyogram and skin conductance measures are based on logarithmic values (logarithmic task scores – logarithmic baseline scores).

Table 1

Overview of Statistical Effects

	zygomaticus major			corrugator supercilii		
	F(1, 38)	*p*	η^2	*F*(1, 38)	*p*	η^2
A	0.20	*ns*	.01	0.06	*ns*	.00
IP	**20.71**	**< .0001**	**.35**	**27.93**	**= .000005**	**.42**
GC	**4.85**	**< .05**	**.11**	**17.96**	**< .0005**	**.32**
A x IP	0.41	*ns*	.01	**7.90**	**< .01**	**.17**
A x GC	0.22	*ns*	.01	0.96	*ns*	.02
IP x GC	**6.96**	**< .05**	**.15**	**8.82**	**< .01**	**.19**
A x IP x GC	0.95	*ns*	.02	*3.51*	*= .07*	*.08*

	extensor digitorum			heart rate		
	F(1, 38)	*p*	η^2	*F*(1, 38)	*p*	η^2
A	0.28	*ns*	.01	*3.82*	*= .06*	*.09*
IP	0.06	*ns*	.00	**5.96**	**< .05**	**.14**
GC	0.09	*ns*	.00	**7.37**	**= .01**	**.17**
A x IP	2.63	*ns*	.07	0.01	*ns*	.00
A x GC	0.09	*ns*	.00	0.16	*ns*	.00

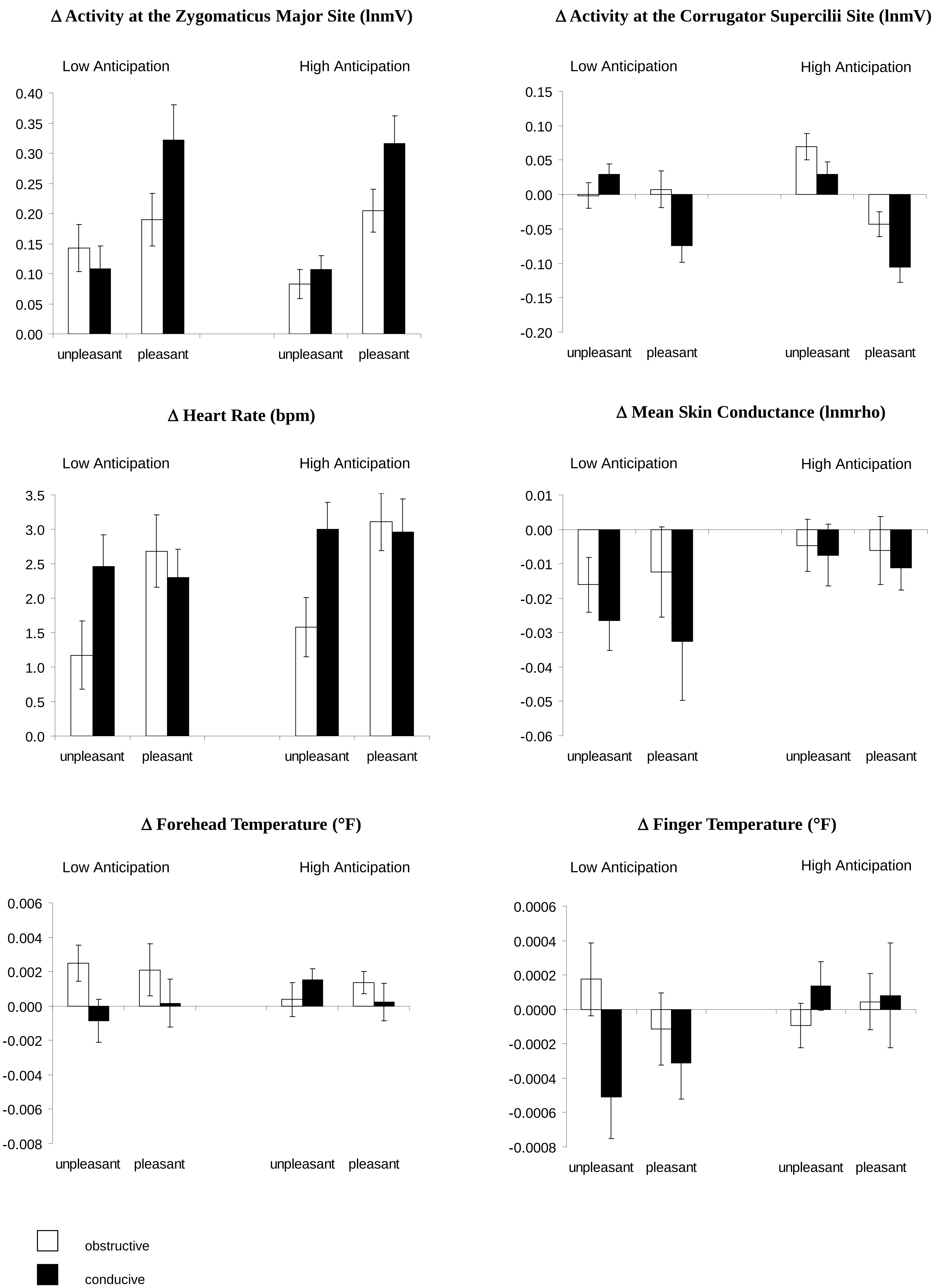
IP x GC	0.60	*ns*	.02	**5.07**	**< .05**	**.12**
A x IP x GC	0.04	*ns*	.00	0.01	*ns*	.00

	mean skin conductance			forehead temperature		
	$F(1, 38)$	p	η^2	$F(1, 38)$	p	η^2
A	*3.31*	*= .08*	*.08*	0.02	*ns*	.00
IP	0.07	*ns*	.00	0.02	*ns*	.00
GC	***3.95***	***= .05***	***.09***	**6.14**	**< .05**	**.14**
A x IP	0.02	*ns*	.00	0.13	*ns*	.00
A x GC	1.42	*ns*	.04	**5.63**	**< .05**	**.13**
IP x GC	0.21	*ns*	.01	0.15	*ns*	.00
A x IP x GC	0.13	*ns*	.00	2.10	*ns*	.05

	finger temperature		
	$F(1, 38)$	p	η^2
A	2.32	*ns*	.06
IP	0.00	*ns*	.00
GC	1.04	*ns*	.03
A x IP	0.09	*ns*	.00
A x GC	**4.52**	**< .05**	**.11**

IP x GC	0.26	*ns*	.01
A x IP x GC	1.10	*ns*	.03

Note. Based on 2 (anticipation: low, high) × 2 (intrinsic pleasantness: unpleasant, pleasant) × 2 (goal conduciveness: obstructive, conducive) ANOVAs. Significant effects are depicted in bold, marginally significant effects in italics. A = anticipation; IP = intrinsic pleasantness, GC = goal conduciveness.


Δ Activity at the Zygomaticus Major Site (lnmV)
Low Anticipation
High Anticipation
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
unpleasant
pleasant
unpleasant
pleasant
Δ Activity at the Corrugator Supercilii Site (lnmV)
Low Anticipation
High Anticipation
0.15
0.10
0.05
0.00
-0.05
-0.10
-0.15
-0.20
unpleasant
pleasant
unpleasant
pleasant
Δ Heart Rate (bpm)
Low Anticipation
High Anticipation
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
unpleasant
pleasant
unpleasant
pleasant
Δ Mean Skin Conductance (lnmrho)
Low Anticipation
High Anticipation
0.01
0.00
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
unpleasant
pleasant
unpleasant
pleasant
Δ Forehead Temperature (°F)
Low Anticipation
High Anticipation
0.006
0.004
0.002
0.000
-0.002
-0.004
-0.006
-0.008
unpleasant
pleasant
unpleasant
pleasant
Δ Finger Temperature (°F)
Low Anticipation
High Anticipation
0.0006
0.0004
0.0002
0.0000
-0.0002
-0.0004
-0.0006
-0.0008
unpleasant
pleasant
unpleasant
pleasant
obstructive
conducive